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THE RELATION OF SCIENTIFIC RESEARCH TO AGRICULTURAL PROGRESS[1]

By Dr. A. F. WOODS

DIRECTOR OF SCIENTIFIC WORK, U. S DEPARTMENT OF AGRICULTURE

A HALF century of service in finding and proclaiming facts underlying agriculture is a record worthy of the highest commendation. The world as well as the nation and the state have felt the helpful influence of the work of this station. It has been in the past and is to-day an active, helpful unit in the great federation of workers, ever seeking by new and improved techniques and clearer vision to give man surer control of those factors of his environment that make up what we call agriculture. It is a wide field, involving almost the whole range of our physical and biological environment, including man himself.

We may well pause at this half-century mark and ask how much we have gained through the development of natural sciences bearing on agriculture.

A half century ago it looked to the best scientific minds as if increase in population would overtake and pass our power to produce food to meet the need. The zero hour was set at about 1933. The day is here. Populations have increased at about the ratio figured, but we can feed them all to-day more easily and cheaply than we could at any time in the past. There is less famine, less suffering, less hard work, and more leisure than ever before. The reason is that we have more accurate knowledge of the factors that must be controlled and we control them better than ever before in the history of man. This knowledge we have gained step by step through carefully planned experiments and the development of what we call scientific method, which is simply a method of trial by which we are able to measure and control each step or process and thus find the true relation of each factor under each set of controlled conditions.

[1] Address at the celebration of the fiftieth anniversary of the founding of the New Jersey Agricultural Experiment Station, October 8, 1930.

From such observations modes of action can be determined and controlled and thus we formulate what we call our physical, chemical and biological laws. These laws operate with considerable certainty within the range of our observation.

It is this method that has given birth to what we call modern science. Some of it has grown out of a study of plants and animals under domestication, as Darwin's formulation of his theory of natural selection, Mendel's studies of inheritance of unit characters and his formulation of the manner of inheritance of such characters now known as Mendel's laws. These two deductions have given us greatly increased power to modify species and to make new ones embodying new unit characters and consequent qualities and to have these fixed true as in nature. But while nature may take a thousand years to produce a new species we can do it in a very few years or in some cases in a few weeks.

The plant and animal have become as plastic in our hands as the molecule and atom have in the hands of the modern chemist and physicist. A new world of interest and power has opened up to us that we have scarcely yet begun to explore.

This increased knowledge and power has been acquired not by spinning logical theories but by observing and testing and basing our hypotheses and theories on observed and tested facts.

In this work the agricultural experiment stations have been busily engaged for over half a century. They have as a result built up a body of experimental evidence in relation to almost every aspect of agriculture and country life that is gradually changing the whole aspect of agriculture in enlightened countries from a haphazard, rule of thumb work for peasants to a dignified, interesting and successful group of industries, able to hold their own, and to render efficient service in civilized society.

This may sound strange to ears that have for so long listened to the wail of the downtrodden farmer. It is necessary to use an intellectual grid screen to eliminate this static in order to get the true symphony of the new agriculture born of the scientific spirit.

THE SOIL

The soil to-day is not just dirt but a universe of life and activity, billions of organisms from the microphages—invisible under the highest powers of the microscope, bacteria, protozoa, microscopic algae, molds, fungi, and a multitude of higher forms, all engaged in breaking down and building up processes that all together make soil.

The factors that favor the fertility-producing and conserving processes are being discovered, as well as those that work in the opposite direction. We are learning to promote the helpful activities and to suppress the harmful activities. The chemists have discovered that out of all these activities there are developed certain colloidal substances that have much to do with what we call soil type. These colloids, with the organic matter which in the past we have lumped under the term humus, have a controlling relation to crop-producing power.

These and other factors are all considered in our soil surveys and land classification as a basis for a more highly developed and permanent agriculture and in reclamation procedures.

Then, too, we are beginning to realize the tremendous losses of fertility and waste of soil from slow as well as rapid erosion and we are beginning to take steps to prevent these losses as far as possible.

The New Jersey station is one of the foremost leaders in this soil research.

THE PLANT

The old botany was largely the naturalists' interest in the orders, species and varieties of plants as they occurred in nature. Down to the time this station was founded plants as well as animals were everywhere considered as fixed entities that might vary a little under changing conditions of environment, but always remained within the fixed bounds in which they were created.

As I have already suggested, this viewpoint has been changed as the result of research. We still have the families and species, but they are more or less plastic in the hands of the geneticist. We have learned that the hereditary characters are carried in the chromosomes of the germ plasm nucleus and that these chromosomes are made up of smaller bodies not much larger or more complex than some of our chemical molecules. We have learned that these have a definite relation to each other in the chromosome and that this definite relation controls the form and activity of the individual resulting from the egg cell.

Regroupings can be produced by crossing or hybridization or can be brought about by other means, such as certain forms of radiation, thus producing mutations in enormous numbers from which selections may be made. Much of this work has been done by our stations.

It is fundamental research that is giving us increasing control of these processes that nature uses in her evolutionary development. The time factor has been greatly decreased.

New corns, new wheats, new sugar canes, new cot-

tons, new varieties of grasses and clovers, new fruits, new flowers, have been produced by the thousands by controlled breeding. We now search the earth for plants having unit characters that we may need as well as already developed varieties. Cold and drouth-resistant wheats and alfalfas, wilt-resistant cottons, cowpeas, flax, melons, sugar canes resistant to virus diseases, potatoes resistant to these and other diseases have been produced. The plant breeders are constantly improving, developing and adjusting crop plants to various limiting factors and quality requirements.

We have long realized how fundamentally important plant life is to the existence of animal life. We know that plants are able to combine carbon, hydrogen, nitrogen into forms available to animals. They do this with energy absorbed from sunlight. We have known a little of these products of photosynthesis, starch, sugar cellulose, pectin, organic acids, and a host of other organic products about which we know very little.

Recently our station investigators have opened up a new field in the so-called vitamins that are found to have extremely important relations to animal development. They control growth and reproduction, resistance to many diseases in animals and man. Almost every year our investigators are bringing new aspects of these important matters to light.

Then there are other light relations that have only recently been discovered, *viz.*, the relation of periodicity of light exposure to the development of plants. In nature this is regulated by the seasons and by day and night. We have developed some control of resting periods and growth, but flowering and fruiting in the majority of cases could not be controlled until one of our scientists discovered that by changing the length of exposure to light and darkness he could change the flowering and fruiting period. This is proving to be a most helpful control in bringing plants to bloom at a desired period, either for commercial or research purposes. It is a new field in which there is research yet to be done.

There are many chemical processes carried on by plants that yield extremely valuable food and medicinal products that have been produced with difficulty or not at all by the biochemist in his laboratory. In some cases it would be extremely valuable to be able to produce these more cheaply and rapidly than can be done by plants.

Among these is an organic poison known as rotenon, produced by a number of tropical shrubs and extremely valuable as an insecticide because it is not poisonous to the warm-blooded animals and is extremely poisonous to insects both as a contact and stomach poison. If we could find out how this is synthesized in the plant it might give us a clue to chemical synthesis in the laboratory and this in turn might lead to efficient commercial production.

The same is true of nicotine, another valuable insecticide, but more or less poisonous to higher animals. The supply available from tobacco waste is not sufficient to meet the requirements. A synthetic material very closely related but not quite so effective as nicotine has been developed but we hope to improve on it.

Bacteria of certain types are able to fix atmospheric nitrogen and make it available to higher plants. The process is rather slow but the method is far more efficient than anything we yet know in our laboratories, with all the improvements we have made in the past few years. How does the bacterial cell accomplish this fixation? If we can find out perhaps it may suggest further improvements in our laboratory and commercial processes.

These examples will indicate the great importance of research in these fields.

Our plants, like animals, are subject to disease. Disturbances in nutrition, attacks by bacteria and fungi, and the filterable viruses cause hundreds of millions of loss every year.

A new science, phytopathology, has been developed in our efforts to cope with these diseases. The first progress along control lines was in the use of fungicides. The U. S. Department of Agriculture and the experiment stations have led the world in this development. The same is true in regard to insect pests. The warfare grows more intense every year. The increasing ease of communication between hitherto isolated regions has made it possible for many fungous and insect parasites to move to cultivated plants related to their wild hosts. With the improved food conditions they multiply enormously and become major pests. Plant lice, leaf-hoppers, grasshoppers, crickets, potato beetles, are all well-known examples of those that have moved from wild to cultivated plants. The cotton boll weevil, the pink boll worm, the Japanese and Asiatic beetles, the corn borers, the Mediterranean fruit fly, and others too numerous to mention, are some that have been brought in. Here, free from their enemies, they have become a serious menace to our agriculture. Most of them can not be eradicated, so the best that we can do is to import their enemies when those enemies are not likely to be injurious, and also to develop other means of suppression and control.

This involves a careful, detailed study of the life and habits of all these pests, but it is the only hope

of successfully keeping them in check in highly developed agricultural regions.

The same is true of plant parasites, rusts, smuts, mildews, bacteria, and hosts of others. One little fungous parasite is rapidly killing off our chestnut forests. No adequate means of control has been found. A destructive elm disease is knocking at our doors, and there are many others known and unknown that must be kept out. But I must not linger in this fascinating field, though I have barely touched it.

ANIMAL INDUSTRY

Another phase of our agriculture of outstanding importance is animal husbandry. It transforms the lower-grade food products into those of higher value —milk, butter, meat and by-products. The progress that has been made in animal breeding is well known to all.

In recent years, however, much greater efficiency has developed in breeding for efficiency of performance in a desired line rather than for certain unimportant characters. Our stations and the U. S. Department of Agriculture have led in developing these methods through more careful application of the laws of genetics.

In the field of animal nutrition great advances have been made—the balanced ration, the relation of the quality of the ration to the quality of the product, the discovery of vitamins, all grew out of this work, and it is only in its beginning.

Very great contributions have been made in the study and control of animal diseases. Perhaps the outstanding contribution was the discovery by workers in the Bureau of Animal Industry of the Department of Agriculture that a microorganism found in the blood of cattle suffering with a disease known as Texas fever was the cause of the disease and that the cattle tick is the means whereby this disease is transmitted. This was the first demonstration that a microbial disease could be transmitted through the intermediate host or carrier.

This discovery ranks among the great achievements of medical science. It led to the discovery that other diseases, like malaria and yellow fever, are carried by mosquitoes, typhus fever by lice and other insects, African sleeping sickness by a fly, Rocky Mountain fever by a tick, etc.

This knowledge gave the key to the development of methods of eradication and control.

As stated in the Yearbook of the U. S. Department of Agriculture, 1930, studies begun in the same bureau in 1885 showed that resistance to disease could be produced by injection of killed cultures of the organism causing it. This led to the development of the method of vaccination against typhoid fever and other bacterial diseases.

Many other fundamental researches on animal diseases have been made by the department and the stations that have been of inestimable value not only to agriculture but also in the treatment of the diseases of man.

In the field of animal parasites an outstanding example was the discovery by a department scientist of a new species of hookworm that attacked human beings in our Southern states and many tropical countries. Effective remedies were also discovered by the department.

Through the efforts of the International Health Board of the Rockefeller Foundation the methods have been used in many millions of cases in all parts of the world. Bovine tuberculosis, hog cholera, and a host of other diseases have been investigated and important progress made in controlling them. No branch of the work of these institutions has rendered more important service to agriculture and to humanity or offers greater promise of future service.

It is a mistake to say that the work done by the Department of Agriculture and the experiment stations is for the benefit only of a class or in the interest of pigs and corn. It is of direct service to every man, woman and child in America, and I think I may safely say in the world, as scientific discovery knows no bounds. It belongs to all the world.

Recent legislation has enabled the department and the stations to study more deeply in the economic and social fields. While great contributions have been made individually in these fields by the department and the experiment stations very little thoroughgoing, systematic study has been carried out. Much, however, is now being organized and we may look in the future for a more scientific basis for our economic and sociological planning.

All the great undertakings, including industries and business, rest upon carefully ascertained facts. They have their scientific agencies to get the facts and to search for still more facts and means of applying them to advantage.

Agriculture spends through the Federal Government and the experiment stations close to $30,000,000 a year for a $60,000,000,000 group of industries, with an annual turnover of $10,000,000,000. This investment has made American agriculture, with all its shortcomings, the best in the world. Other industries spend nearly $200,000,000 for research and the amount is increasing yearly. It is the way of progress and safety and offers most for the present and future welfare of man.

THE LANGUAGE OF SCIENTISTS[1]

By the Reverend GEORGE W. LAY
CHAPEL HILL, NORTH CAROLINA

HAVING been a student of language for many years and observant especially of the language of scientists, I thought that a paper on the subject might prove both appropriate and interesting. Scientific specialists are not always interested in papers on other specialties, but all are interested in interpreting the language of nature. The knowledge thus acquired must be passed on to others by means of the written or spoken word. All should therefore wish that such ideas should be expressed in language clear and accurate, and worthy of the great cause of science. Especially is this true when we reflect that many of us are teachers. Therefore I hope that you will be interested.

I was a little doubtful of the propriety of my choice of subject, until I found that in the program of the American Association for the Advancement of Science, to which doubtless many of us belong, Section L is devoted to "historical and philological sciences," and the proceedings of the last meeting of the association record what was done under the head of "the linguistic sciences part of Section L." Hence I hope my subject is a proper one for this body.

Lawrence W. Wallace, of Washington, D. C., secretary of the American Engineering Council, is quoted in SCIENCE[2] as saying: "Men of science . . . by supplementing with broad humanistic and scholarly interests the technical genius responsible for the Machine Age . . . are becoming a controlling force in culture and in politics no less than in commerce and industry, in finance, in education and in national defense." He mentions that the President of the United States, two members of his cabinet, many members of the two houses of Congress and ten governors of states, including our own governor of North Carolina, are men of science, or hold scientific degrees, or both. If they are to be leaders in culture, the responsibility of scientists to cultivate and use the best English would seem to be very great, in spite of the very natural temptation to regard language as something foreign to their own specialties. They need to acquire a linguistic conscience, a sensitive ear and a wise discrimination, as they hear or speak or write the English language. Then consider the great harm that may be done to vast numbers of the younger students of science if they carry from the classroom slovenly, or absolutely incorrect, modes of speech. Once a charming co-ed graduate student, after telling of the gross mistakes of her learned scientific professors, including mention of one "Ar chím edes," with mournful tones said to me, "I sometimes despair of the future of the English language." I am not so pessimistic as she, but I do think we need to be very careful.

Allow me first of all to call attention to some of the mistakes into which we are liable to fall when from carelessness or inadvertence we follow the vulgar crowd. There is a tendency in America to accent the first syllable of many words where true culture demands an accent on the second syllable. If we say, and even defend, "ré search," "ré sources" and the "U'nited States," we shall have plenty of support, but not from those who are most cultivated in their speech. Also, if we are consistent, we must say ád dress, dí rect, dís charge, éx cess, hó tel, mág azine, moús tache, úm brella, Dé troit, Sé attle, cí gar and cíg arette.

Another common tendency in America is to give a word two accents, where only one is proper. I once lived in a city where some of the streets were named after trees. Several of my friends lived on what they called "Sassy Frass Street." I never found its companion, "Polite Frass Street." The worst example is "Hoss Spittle." Of course none of you say this, but notice your friends carefully and you will find that most of them so pronounce it. It is a most uncomfortable word, and reminds me of my youthful experiences when driving against the wind in the old horse-and-buggy days. Millions of our boys, being familiar with speedometers and cyclometers, brought back from France the word *ki-lom'eter*. This has been taken up by some scientists. Soon we shall be hearing of cubic *centimeters*, and then of *kilogrums*, to agree with those perfectly horrid words, *progrum* and *telegrum*.

Many words are distinguished as nouns or verbs by taking an accent on the first syllable as nouns and on the second as verbs. Pronounced as verbs, some of them are as follows: ac-cent', af-fix', pre-fix', suf-fix', con-trast', con-tract', ex-tract', in-crease', con-test' and con-vict'. It may please you for me to confess that I had been teaching the intricacies of Greek ác-cent for many years before I learned that I must teach my pupils how to ac-cent'.

A lack of knowledge of the classic languages, or

[1] A paper read before the North Carolina Academy of Science at Duke University, May 9, 1930.

[2] "Engineers in American Life," SCIENCE, 71: 28, January 10, 1930.

carelessness in the use of what little knowledge one has retained, leads to many regrettable blunders. Words of the fourth declension in the Latin are sometimes used improperly, and the English plurals of words from Latin or Greek are used incorrectly. One can not preserve the *statu quo,* or keep things *in status quo.* One can say "many apparatus" or "many apparatuses," but not "many apparati." "Many alibi" is also indefensible. I have read the frenzied defense of "this data is"; but for one with a linguistic conscience it simply isn't done. If one can agree with that defense, it would seem fair to excuse even the Harvard professors whom I have heard say "a strata" and "a suitable media."

If one is going to use a phrase or word from a foreign language, it is quite necessary to know the meaning in that language. Otherwise many mortifying mistakes will be made. By most people *per* and *via* are thought of as simply meaning "by," with no distinction between *per,* "by means of a specified agent," and *via,* "by a specified route." But one sometimes reads of things sent *via* Mr. Smith.

Then the French word *née* is equivalent to the Latin *nata.* It is feminine and means "born." It is properly used in giving a woman's maiden name, which is the only one she has at birth and the one that frequently she is quite willing later to discard. In the description of a widow's second marriage I have heard of Mrs. John Jones, *née* Mrs. Samuel Smith, *née* Miss Mary Robinson. This seems to be carrying the idea of regeneration to a rather unwarranted extreme. And in the *Popular Radio Magazine,* a supposedly scientific periodical, I found this delicious bit: "Leningrad, *née* Petrograd, *née* Saint Petersburg." Of course these writers thought of *née* as simply meaning "formerly," and let it go at that.

With a friend of mine, who kindly allows me to use the occurrence as an illustration, I had a conversation which shows the necessity of a scientist's having at least sufficient knowledge of Greek to be able to look up words in a Greek dictionary. He asked me whether *Rhizopogon parasiticus* was correct. The former word looks like a common neuter form. Should *parasiticus* be masculine? Now many of the scientific Greek words for genera are not found in ordinary Greek literature. I could not answer the question offhand. There was a large room full of all kinds of books on botany, but no Greek dictionary. I asked him, "Do you say rhizó pogon or rhizopó gon?" He answered, "I say *rhizopó-gon,* but I don't know why." After consulting a Greek dictionary at home I was able to tell him that *rhizopogon* was masculine in Greek and that each of the last two "o's" was omega, or long "o," in Greek, and that therefore the penult took the accent. He was correct about both points, but could not be sure. He then showed how a little learning is sometimes a dangerous thing. He asked me the derivation of "pyrenomycete," saying that of course *pyr* meant fire. I said, "I am not sure of that. Where would you get the *eno?*" This time I only had to consult a big English dictionary, verifying the information by the Greek dictionary. So I told him that the chemical term "pyrene" was indeed from "pyr," but that the botanical term "pyrene" and the combining form "pyreno" were both from the Greek stem *pyreno,* meaning the stone of a fruit, as of a drupe or drupelet.

An example of ignorance or carelessness appeared in an important paper by an eminent scientist that was published in SCIENCE. Carnivora, herbivora and omnivora are neuter plurals, but they have the same ending as many feminine singular nouns of the first declension in Latin. This paper spoke of the carnivorae, herbivorae and carnivorae, and rubbed it in by using herbivorae again on the same page. When I asked the writer about it, he acknowledged his carelessness, but made the plea in extenuation that SCIENCE printed it that way. This was a pretty hard knock on SCIENCE.

An interesting point about homonyms, or words that are pronounced alike but differ in spelling and meaning, was brought out by a geological friend who said that to distinguish between syenite (or sienite) and cyanite he pronounced the latter with a hard "c," like "k." I said, "You can't do that. Before that vowel sound 'c' must be soft; but you can say 'kya-nite,' if you spell it so, that being a permissible form of the word."

Scientists are overwhelmed by the vast number of new facts discovered and the many new theories or explanations of these facts. In each such case a new word must be devised to express the new idea. These words are practically always derived from the Latin or the Greek, of which languages scientists are, as a rule, largely ignorant. The English dictionaries are often of no help, since the words are invented and come into general use long before the dictionaries can put them into print. There would seem to be immediate need for some central authority to determine correct terminology and the proper and exact meaning, spelling and pronunciation of new words. I mention certain obvious points.

Mongrel or hybrid words constitute a linguistic crime. Generally speaking, a word should be all Latin or all Greek. To be sure, some combining forms from the Greek have been so completely naturalized in Latin and English that they may be used indiscriminately. Such forms as *pro-* and *anti-* and

-ology are examples. We even say "Roentgenology." But there is no palliation for the linguistic crimes of "hypersensitive" and "hypertension" when we can say "supersensitive" and "supertension," or "television" when we might have invented something like "teleopsis."

Such a central authority could insure that every new word had a perfectly definite and exact meaning which would be recognized by all scientists. Attention has been called recently to two examples of unscientific confusion in the meaning of words. It is asserted that "micromicron" is used by physicists with one value and by biologists and chemists with another. One value is a thousand times greater than the other. Then some one has invented another word, the "bicron," all by himself. I have met no scientist who had heard of it. Yet it has crept into some dictionaries. Likewise the symbols for micron, millimicron and micromicron do not seem to be settled in a way universally accepted. The U. S. Bureau of Standards is definite and precise in this regard, but seems to lack the respect of some. The other example is the word "pedology." The soil men derive it from a Greek word meaning earth. Some one points out that this is a very recent use of the word, and that it has been used for over thirty years to mean child study, with a derivation from another Greek word meaning child, like "pediatrics" and "orthopedics," which are not derived, as many suppose, from the Latin word for foot. Next a soil man tells me that pedology was used by the Russians and other European scientists to mean soil science long before it was used for child study. Surely science should not allow such confusion.

Nomenclature is an exceedingly important subject. So important is it that in the account of creation in the second chapter of Genesis we are told of the first authority on nomenclature. The animals were brought to Adam "to see what he would call them. . . . And whatsoever Adam called every living creature, that was the name thereof." I am far from regarding this account as a literal record, but at least it shows an early recognition of the importance of correct names in science.

Not only should scientific names be definite; they should also be as simple as possible so as to be easy to remember and pronounce. In SCIENCE for January 10, Professor James G. Needham, of Cornell University, mentions a poor little innocent amphipod crustacean that is burdened with the name *brachyuropushkydermatogammarus grewinglii mnemonotus* Dybowski, and a very small fish named *microstomaticoichthyoborus bashford-deani* Nichols and Griscom. It sounds like a college cheer. He objects to having to manage such jawbreakers and claims that a name is a name to call a thing by, and not a definition or a memorial to a discoverer. Instead of the former of the two examples of sesquipedalianism he proposes *Gammarus mnemonotus,* and nothing more, as being definite, simple and quite sufficient. I am sure it would also be more pleasing to the dear little member of the Gammaridae not to be called hard names.

Finally I wish to say that I fully appreciate the difficulties under which scientists labor. Little help is given in scientific books as to derivation or pronunciation. It would be well if all scientific textbooks at least gave both the derivation and the accent of words derived from foreign languages. Scientists can not even trust each other. I am told that the same word may be pronounced in one meeting in one way and in quite a different way at another meeting held shortly after in another part of the country. My sympathy is the greater and more genuine since I am all the time discovering words that I have mispronounced for many years.

This is preeminently a scientific age. Scientists are leaders. I hope that I have helped to make clear the great opportunity presented to all scientists to be leaders in culture, as well as in the ascertainment of facts and the explanation of phenomena.

OBITUARY

MEMORIALS

WILLIAM BARTON ROGERS, first professor of natural philosophy at the University of Virginia, will be honored on December 7 by a ceremony at which the presidents of two institutions will speak. The Technology Club of Virginia, composed of alumni of the Massachusetts Institute of Technology, will unveil a bronze tablet in the Cobb Chemical Laboratory, commemorating Rogers's connection with the University of Virginia and with the Massachusetts Institute of Technology. Rogers, who was a member of the Virginia faculty from 1835 to 1853, went to Massachusetts where he founded the institute in 1859, to serve later as its first president, from 1865 to 1870, and again during the years 1878 to 1881. The dedication exercises will take place in the Cobb Laboratory on Sunday, December 7, the one hundred and twenty-sixth anniversary of Rogers's birth. The presentation will be made by Mr. J. Scott Parrish, Richmond, president of the Technology Club of Virginia. Acceptance for the university will follow by President Edwin A. Alderman. The services of Rogers to Virginia will be

described by Dr. Llewellyn G. Hoxton, head of the school of physics, third occupant of the chair originally held by Rogers. Dr. Samuel W. Stratton, chairman of the board of the Massachusetts Institute and former president, will deliver the address in which Rogers's contributions to the institute are described. The tablet is to be installed beneath an oil painting of Rogers which was done in 1881 and which hangs at present in the Cobb Laboratory. This painting was one of the few things saved when the former laboratory burned to the ground. It suffered only slight damage.

THE building for geology at the University of Missouri has been named George C. Swallow Hall in honor of George Clinton Swallow, first professor of geology in the university and first state geologist of Missouri. Dr. Swallow went to the university in January, 1852, as professor of chemistry, geology and mineralogy. In 1853 he was appointed state geologist, resigning from the university faculty. Later he returned to the university as professor of agriculture. A monument in the Columbia Cemetery, where he was buried, calls him the "first professor of geology, chemistry and agriculture, and the first dean of the College of Agriculture in the University of Missouri, and the first state geologist of Missouri." The monument was erected by the Boone County Historical Society in 1928.

A SCHOLARSHIP has been founded at University College, Southampton, by friends of the late Dr. Alex Hill, in recognition of the distinguished services rendered by him as principal of the college. Previously Dr. Hill had been professor at the Royal College of Surgeons, and master of Downing College, Cambridge.

A MEMORIAL address of the character and work of the late Sir H. Baldwin Spencer was delivered on October 31 in the museum by Mr. T. K. Penniman, president of the Anthropological Society of the University of Oxford.

THE *Journal* of the American Medical Association reports that a bronze portrait bust of Louis Pasteur, through the will of Dr. Arthur C. Hugenschmidt, a friend, who died in Paris last year, has been sent to the University of Pennsylvania. The bust was first placed on public view in the school of medicine, October 10, when a two-day celebration commemorating recent progress in medicine was opened. Dr. Hugenschmidt, dentist to Pasteur, was presented with the bust by Madame Pasteur.

THE council of the senate recently reported to the University of Cambridge on a proposed James Clerk Maxwell centenary celebration. A committee of eminent men of science and others have suggested that the university should celebrate the centenary of his birth, which occurred on June 13, 1831. The suggestion has been approved and it is recommended that the centenary should be celebrated on October 1 and 2, 1931.

RECENT DEATHS

DR. GUSTAVE MAURICE BRAUNE, since 1922 dean of the school of engineering at the University of North Carolina, died on November 26, at the age of fifty-eight years.

DR. JOHN L. TILTON, professor of geology at West Virginia University, died in his classroom on November 17. He was sixty-two years old.

HARRY CHAPMAN WARDELL, curator of industrial science in the Rochester Municipal Museum of Arts and Sciences, died on November 18.

DR. RICHARD MOLDENKE, consulting metallurgist, formerly of the U. S. Coast and Geodetic Survey and of the Michigan College of Mines, died on November 17, at the age of sixty-six years.

THE death is announced in a Reuter message from Wellington, New Zealand, of Robert Julian Scott, emeritus professor of engineering at Canterbury College, who was head of the School of Engineering from its foundation in 1889 until he retired in 1923. Professor Scott was sixty-nine years old.

THE deaths are announced of M. Philippe Glangeaud, professor of geology at Clermont-Ferrand, member of the section of mineralogy of the Paris Academy of Sciences, and of M. Emile Godlewski, honorary professor of physiological botany at Cracow, correspondent in the section of rural economy.

CAPTAIN OTTO SVERDRUP, the Scandinavian explorer, died at Copenhagen on November 26, at the age of seventy-six years. He was a close associate of the late Dr. Fridtjof Nansen.

DR. SCHEVIAKOFF, the Russian zoologist, especially known for his work on the Protozoa, died at Irkutsk on October 18.

SCIENTIFIC EVENTS

PANEL OF EXPERT TRANSLATORS

THE Association of Special Libraries and Information Bureaux, of which Sir Joseph J. Thomson is president, announces a scheme whereby the association will act as intermediary between translators and users by establishing a panel of translators possessing the

double qualifications of proficiency in one or more languages and expert knowledge of one or more subjects.

A translator who wishes to be registered on the panel is required to answer a questionnaire (which can be obtained by application to the secretary of the Association), which is framed so as to provide the association, in addition to necessary particulars, with full information regarding the applicant's qualifications, linguistic and technical. Applications are considered by a board, whose decision is final. In certain cases the board may require the applicant to submit to a test. As a rule only individuals are eligible for registration, but commercial translating bureaus may apply for registration in respect of full-time employees, or by satisfying the board of their ability to undertake high-class specialized work.

An applicant may apply to be registered for any foreign language and for any number of foreign languages, but a high standard will be required by the board. A "fair" knowledge of a language will not be accepted, except in special circumstances, for example, where, without possessing a general knowledge of a language, an applicant has special knowledge of some technical terminology in it.

An applicant may apply to be registered for any subject and for any number of subjects, provided that these are sufficiently specialized. What is meant by "sufficiently specialized" can not be closely defined. Broadly speaking, the "commoner" the language the higher will be the degree of specialization required. An applicant fully qualified in a "rare" language, such as Chinese, Hungarian, or Turkish, might be accepted with little or no specialized knowledge of any subject. Applicants must use their judgment in this matter and give as much information as possible. If in doubt they may, before completing the questionnaire, send in an inquiry as to whether their subject is likely to be acceptable to the board. All branches of knowledge—science, law, the arts, etc.—come within the scope of the scheme.

The panel should include translators living in any part of the country and applications are considered from those living abroad. Part of the value of the scheme to users is that, in cases where time is an important factor, it may be possible to put them into touch with a suitable translator living in their own locality. On the other hand, when the question of time is less serious and the subject-matter particularly difficult it may be worth while to send the work abroad.

Included in the panel are those who are prepared to act as interpreters. The need for this kind of assistance arises frequently when interviews take place between English people and foreign visitors. Often they know no language in common or their knowledge is not good enough to enable them to discuss technical matters.

The panel is a private register belonging to the association, and it will not be published. To members of the association the service is available without charge. To others a charge is made in respect of each name and address given. Once the association has served the purpose of effecting the introduction, which may establish a permanent connection of value to both parties, its interest in the matter ends.

THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

M. CHARLES LORMAND, of Paris, contributes to *Industrial and Engineering Chemistry* an account of the tenth conference of the International Union of Pure and Applied Chemistry, held in Liége from September 14 to 21, and of particular significance in that it became truly international. The German chemists, who at the preceding conference at The Hague had been invited to join the union, in the meantime had formed in Germany a federation of chemical groups. This federation sent to the Liége conference an important delegation composed of the most distinguished German chemists.

The union decided this year to suspend the activities of its committees, which had been censured for their concentration solely upon administrative work. Certain committees had been dissolved because of these criticisms. They will now, however, resume their full activity in the more extensive field of the congresses which they will call together.

This year a series of reports on sugars was placed in the order of the day. The president of the scientific committee of organization of the union, Professor Délépine, had asked several representative chemists to give reports, followed by discussions, on the results they had achieved in this field. The series of conferences which was thus held in Liége included all aspects of our present knowledge of the chemistry of sugars, starch and cellulose. Gabriel Bertrand, in the first report, gave the present status of our theoretical concepts of the constitution of sugars, and, in the course of the three days which followed, Messrs. Haworth, S. Hudson, T. M. Lowry, Smith, A. Pictet, Karrer, H. Pringsheim, H. Mark, Emil Heuser and Ettore Viviani reported in succession on the structure of sugars, the relation between the constitution of sugars and their rotatory power, the constitution of starch and of polysaccharides, molecular weights and the use of X-rays in the study of structure, the constitution and properties of cellulose and lastly on the constitution and physical properties of artificial silk.

Each of these reports, given in the language of the author, was followed by a discussion, first in French, then in English and later in German.

The union recorded the forthcoming entry of Swedish chemists.

The International Bureau of Physico-Chemical Standards, a section of the union, reported that more than two hundred samples of calorimetric standards have been distributed to different industrial laboratories. In this connection, a permanent committee on thermochemistry has been formed for the purpose of studying the use of salicylic acid as a secondary standard.

The Committee on Nomenclature of Inorganic Chemistry met under the presidency of Professor Hollman and discussed the different reports presented by Professor Grillart. No change will be made in nomenclature so long as the edition of Beilstein is unfinished. The plan will be drawn up by chemists universally and the bases of nomenclature which are now in use will serve as practical terminology until the new order is established.

Various modifications of statutes required by changes in the statutes of the International Research Council were approved.

The former Committee on Chemical Elements was then dissolved and replaced by three committees. One, the International Committee on Atomic Weights, will publish an annual atomic weight table. This committee is composed of the following persons: Mr. Urbain, honorary president, Mme. Curie, Messrs. Baxter, Hoenigschmidt, Lebeau and Meyer. A second committee, known as the International Committee on Atoms, will study the question of atomic structures. A third Committee on Radioactive Substances, in conjunction with the Committee on Radium Standards, will study radioactive substances solely.

The International Committee on Atomic Weights plans to publish an international table as soon as possible. This is to be the only official table, and to this end atomic weight sections of each separate country will refrain from publishing national tables.

The union will hold its next session two years from now in Madrid; the 1934 session will be held in Switzerland. The union will thus continue to meet every two years. Furthermore, it has decided to resume its international congresses, the last of which met in New York in 1912. Owing to the war, the 1914 congress, scheduled for Moscow, could not be convened. The next congress will be in Madrid in 1932 during the conference of the union. It will be international and will embrace all branches of chemistry, pure and applied. As in the Liége session, a certain number of questions will first be placed in the order of the day and different sections of the congress will receive a limited number of reports. One special committee will be authorized to accept or reject these reports, which should, of necessity, be of truly international interest, and should not duplicate publications which a chemist might present through his national society. In the details of organization of the congress, considerable attention was given to the report of Bernhard Hesse on the Eighth International Congress, and as a result problems, no matter how interesting, will be barred from the session if they are not of international significance.

INTERNATIONAL CONGRESS ON BITUMINOUS COAL

A THIRD international conference on bituminous coal will be held at the Carnegie Institute of Technology in November, 1931, according to a recent announcement made by President Thomas S. Baker, who organized the first two international congresses.

An invitation will be extended to the scientific men of all countries to take part in the meeting, which is the only one of its kind of international scope. Prominent men of affairs in America will assist Dr. Baker in organizing the meeting.

The purpose of the congress will be similar to that of the meetings held in 1926 and 1928: to present for discussion the results of recent studies of coal. Particular attention will be paid to the economics of the new methods and processes that are being evolved, he indicated.

The program will include papers on carbonization, liquefaction and gasification of coal, by-products of coal, the mechanism of combustions, cleaning of coal and its preparation for the market, pulverized fuels, power plants and domestic heating. The discussions will be confined to coal above ground. Beginning at the mouth of the mine, however, practically every phase of distribution and consumption will be treated by outstanding authorities in the several fields.

"The condition of the coal industry during the past few years can hardly be called healthy," President Baker said, "and the current business let-down has brought extreme depression to this basic world industry. We hope that as a result of the discussions held we may be of assistance in uncovering new processes which may help it on the road to recovery."

Announcement of this third world meeting comes in logical sequence to the previous congresses. The first conference was organized by President Baker in 1926 for the purpose of finding new uses for bituminous coal and especially to discuss the problem of liquefying coal to supplement the petroleum oil supply of the world. This meeting, although it was the first of

its kind to be held, attracted 1,700 investigators from thirteen different countries. Two years later followed the second congress which was broader in its scope, including discussions on pulverized fuel, low temperature carbonization of coal, rubber from coal, the hydrogenation of coal and by-product nitrogen. Speakers during the two conferences have included M. Georges Claude, Dr. Friedrich Bergius, Professor Franz Fischer, Dr. C. H. Lander, Dr. R. Lessing, General Georges Patart, Dr. Fritz Hofman, Dr. Karl Krauch and many other fuel technologists.

AERONAUTIC RADIO RESEARCH AT THE BUREAU OF STANDARDS

THE development of radio aids to aviation is being forwarded through work of the National Bureau of Standards, which is operating also as the research division of the Aeronautics Branch, Department of Commerce. In recent months improvements have been made in equipment for use with the system of radio range beacons which the department is installing on the airways. Since a beginning has been made in the installation of beacons of the type which operate a visual indicator, a greater need has been felt for an automatic volume control on the receiving set used aboard the airplanes. Such a device has been developed at the bureau. It relieves the pilot entirely of manipulation in the use of the visual indicator of the beacon signals. It can be used to advantage also in receiving aural-type beacon signals. Another application is in connection with the runway localizing beacon for use either at airports or as part of the system of blind-landing aids which is being developed at the bureau. In connection with the automatic volume control, a deflection instrument is used which serves as an approximate distance indicator. Recent experiments have also added a means of indicating when the airplane is directly over the beacon transmitter, so that the landing field location is thus conveniently and directly indicated to the pilot.

Another device developed at the bureau to facilitate the use of the visual-type range beacon is the "deviometer." By its use a pilot can follow any chosen course, within limits, on either side of the equi-signal line for which the beacon transmitter is adjusted. It is a shunting arrangement which varies the relative current in the coils actuating the two reeds of the reed indicator, and a pointer indicates the number of degrees off the equi-signal line for which the deviometer is set. The device has been found useful in experimental flight tests. The bureau recently furnished one to an air transport company for service tests.

As part of the aeronautical radio work at the bureau special attention has been devoted to receiving sets. For receiving both telephone messages and beacon signals aboard an airplane, receiving sets of special design must be employed. They must be so designed as to function under particular conditions of vibration, local interference, small input voltage, high output level required, and special audio-frequency requirements. The basic designs for such sets have been developed at the bureau. It also keeps in touch with commercial developments in aircraft radio receivers by means of laboratory measurements and experimental trials on an airplane. Satisfactory receiving sets are now found to be available commercially.

SHIPPEE-JOHNSON PERUVIAN EXPEDITION

THE Shippee-Johnson Peruvian Expedition will sail from New York on December 5 to carry out, with the endorsement of the American Geographical Society, a program of aerial mapping in various parts of Peru. The expedition is equipped with two Bellanca cabin monoplanes, one of which will be used for photographic work and the other for transporting supplies. The photographic plane in addition to being equipped with the most up-to-date and efficient of photographic apparatus has a supercharged 300 horse-power motor which will make it possible to rise to altitudes up to 28,000 feet for photographic work in the Maritime Cordillera of the Andes.

The primary purpose of the expedition is to map from the air and study and photograph on the ground the little known agricultural communities on the floor of the deep gorge of the Colca River some seventy miles north of Arequipa. The Chimú Valley, the site of Chan-Chan, the capital of the kingdom of the Great Chimú, whom the Inca conquered shortly before the Spanish conquest, will also be photographed from the air and an attempt will be made to discover whether aerial mapping in the heavily forested eastern valleys of the Andes and the Amazon lowland is feasible.

Lieutenant George R. Johnson, co-leader and photographer of the expedition, served as chief photographer of the Peruvian naval air force during 1928 and 1929, and during that time made a remarkable series of aerial photographs of Peru, a selected group of which the American Geographical Society has just published as full-page illustrations (8½ by 6½ inches) in a book entitled "Peru from the Air."

SCIENTIFIC NOTES AND NEWS

THE gold medal of the Radiological Society of North America has been awarded to Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology.

THE Council of the Royal College of Surgeons has conferred the honorary fellowship of the college on Dr. Banting, of the University of Toronto, the discoverer of insulin. Lord Moynihan pointed out, according to a statement in the London *Times*, that Dr. Banting's discovery of insulin was the first piece of important scientific research in the realm of medicine contributed by the British Dominions. The college accords him the recognition of surgeons of a piece of scientific work of a physiological character bearing on the practice of surgery, though in itself something entirely outside the practice of surgery.

AT the monthly meeting of the American Geographical Society on November 26, the David Livingstone Centenary Medal for 1930 was presented to Dr. Laurence M. Gould for his explorations in the Antarctic.

THE George Robert White Medal of the Massachusetts Horticultural Society has been awarded to Dr. David Fairchild, botanist and explorer, since 1906 in charge of the office of foreign plant introduction of the U. S. Department of Agriculture.

DR. EMILE F. HOLMAN, professor of surgery at Stanford University, has been awarded the Samuel D. Gross prize for his research on abnormal arteriovenous communication.

AT a meeting of the Geological Society of London on November 5, Professor P. Lemoine, Paris, and Professor G. A. F. Molengraaff, Delft, were elected foreign members. Professor R. S. Bassler, U. S. National Museum, Washington; Professor O. Mügge, Göttingen; Dr. D. I. Mushketov, Leningrad; Madame M. Pavlov, Moscow; Professor P. D. Quensel, Stockholm, and Professor E. Stensiö, Stockholm, were elected foreign correspondents.

THE *British Medical Journal* calls attention to the issue of the *Wiener medizinische Wochenschrift* for November 1, which is dedicated to the Vienna pediatrist, Professor Hochsinger, on the occasion of his seventieth birthday, and which contains articles dealing exclusively with diseases of children.

THE title of emeritus professor of electrical engineering in the University of London has been conferred on Professor Ernest Wilson, on his retirement from the university chair of electrical engineering at King's College.

DR. E. H. VOLWILER, director of research of the Abbott Laboratories, North Chicago, has been elected a director of the organization into which the Abbott laboratories and Swan-Myers were recently merged.

DR. STEFAN ANSBACHER, physiological chemist, formerly of the institute of pathology of the University of Geneva, has joined the laboratory staff of the South Carolina Food Research Commission at Charleston.

PROFESSOR GUSTAVO PITTALUGA, director of the laboratory of parasitology at Madrid, has been named director of the Spanish National School of Hygiene.

AT the annual meeting of the American Society of Agronomy, held in Washington on November 20 and 21, the following officers were elected for the ensuing year: *President,* Dean W. W. Burr, University of Nebraska, Lincoln; *Vice-presidents,* Dr. A. B. Beaumont, Massachusetts Agricultural College, Amherst; Dr. S. A. Waksman, New Jersey Agricultural Experiment Station; Professor George Stewart, U. S. Forest Service, Ogden, Utah, and R. I. Throckmorton, Kansas State Agricultural College, Manhattan; *Editor,* J. D. Luckett, Agricultural Experiment Station, Geneva, New York; *Secretary-treasurer,* P. E. Brown, Iowa State College, Ames. Three members of the society were elected fellows. These were: President F. S. Harris, Brigham Young University, Provo, Utah; Dr. James A. Bizzell, Cornell University, and Dr. Walter P. Kelley, University of California. The winners of the Chilean Nitrate of Soda Nitrogen Research Award, sponsored by the American Society of Agronomy, were: Luther G. Willis, of the North Carolina Agricultural Experiment Station; James K. Wilson, of Cornell University, and Joshua J. Skinner, of the Bureau of Chemistry and Soils.

PROFESSOR S. C. BROOKS has been granted a half year's leave of absence from the University of California and will continue his experiments at the Stazione Zoologica, Naples. He will occupy the Woods Hole-Columbia Table there. Dr. Matilda Moldenhauer Brooks has been given a grant from the National Research Council to enable her to continue her oxidation-reduction studies at Naples and will occupy the Woman's Table of the Association to Aid Scientific Work by Women. They will sail from New York on December 16 and will return to Berkeley *via* Japan in August, 1931.

DR. KARL LANDSTEINER, of the Rockefeller Institute for Medical Research, who was recently awarded the Nobel prize in medicine, sailed for Europe on November 25 in order to receive the medal at Stockholm.

DR. ROBERT A. MILLIKAN, of the California Insti-

tute of Technology, will give the Proctor Foundation Lecture at the Brooklyn Institute of Arts and Sciences at the Academy of Music, on Saturday evening, December 13. His subject will be "Exploring the Universe."

DR. EDWIN P. HUBBLE, of the Mount Wilson Observatory, will lecture at the Carnegie Institution of Washington on December 10. The title of the lecture is "The Exploration of Space."

DR. J. B. JOHNSON, research physicist at the Bell Telephone Laboratories, New York, lectured on "The Cathode Ray Oscillograph" on December 4, before the Franklin Institute, Philadelphia.

DR. DEXTER S. KIMBALL, dean of the College of Engineering at Cornell University, lectured at the University of California on December 2 and 4, on "Economic Tendencies in Industry."

DR. B. H. HIBBARD, professor of agricultural economics and head of that department in the University of Wisconsin, will lecture for four weeks at the summer session of the Kansas Agricultural College at Manhattan.

AN illustrated lecture course on astronomy will be given during the winter, both at Pasadena and Los Angeles, under the auspices of the Astronomical Society of the Pacific and the Mount Wilson Observatory. The subjects and lecturers are as follows: "What the Stars are Made of," Dr. Arthur S. King, Mount Wilson Observatory; "Taking the Census in the Solar System," Dr. Seth B. Nicholson, Mount Wilson Observatory; "Comets and Asteroids," Dr. William F. Meyer, president, Astronomical Society of the Pacific; "Celestial Laboratories," Dr. Theodore Dunham, Jr., Mount Wilson Observatory; "The Exploration of Space," Dr. Edwin P. Hubble, Mount Wilson Observatory.

DR. CHARLES F. SWINGLE, Bureau of Plant Industry, U. S. Department of Agriculture, delivered on November 15 a lecture on "Hunting Plants in Madagascar" at the Royal Canadian Institute.

THE Henry Sidgwick Memorial Lecture at Newnham College, Cambridge, was given by Professor A. V. Hill, professor of physiology in the University of London, on November 22. The title of the lecture was "Biology in Education."

Nature reports that the third Liversidge lecture of the British Chemical Society, which was to have been delivered by Professor H. B. Dixon, will be given on December 11 by Professor W. A. Bone, at the Imperial College of Science and Technology, South Kensington. Professor Bone will take as his subject, "Fifty Years' Experimental Research upon the Influence of Steam on the Combustion of Carbonic Oxide (1880–1930)."

A SERIES of lectures is being given at the Institute of the History of Medicine, Johns Hopkins University School of Medicine, by Sir D'Arcy Power, England, honorary librarian of the Royal College of Surgeons. The subjects of the lectures are: "Essentials of Medical Biography," "Medical Bibliography," "The Meals of Our Ancestors," "Aristotle's Masterpiece," "Medical Iconography" and "The Growth of a Hospital."

THE second annual meeting of the American Association of Physical Anthropologists will be held on December 29 to 31, in Cleveland, in affiliation with Section H of the American Association for the Advancement of Science and with the American Anthropological Association. The society's sessions will be held in the department of anatomy of Western Reserve University. A joint meeting and a joint dinner will be held with Section H of the American Association for the Advancement of Science and with the American Anthropological Association. For members desiring to make reservations of rooms, the Hotel Winton is suggested.

THE Central Society for Clinical Research held its third annual meeting at the Research and Educational Hospital of the College of Medicine, University of Illinois, on November 21. About two hundred members attended the meeting. The officers elected for the ensuing year are: *President,* Dr. Louis Leiter, and *Secretary,* Dr. Lawrence D. Thompson.

THE first regular meeting of the American Geographical Society for the season 1930–1931 was held on November 25, at the Engineering Societies Building, New York City, President John H. Finley in the chair. Laurence Gould, of the University of Michigan, addressed the society on his Antarctic field work of 1928–1930. Dr. Gould was the geologist and geographer, as well as the second-in-command, of the Byrd Antarctic Expedition. During the expedition he made two independent trips, one by airplane, to the newly discovered Rockefeller Mountains, 150 miles east of Little America, and the other by dog sledge 440 miles south from Little America to the mountains at the border of the South Polar Plateau. Of these border mountains, for a distance of 250 miles, the first adequate survey was made.

THE fifty-first annual meeting of the American Society of Mechanical Engineers opened on December 1. The ninth national exposition of power and mechanical engineering in which four hundred exhibitors have taken space is being held in connection with the meeting. The engineering departments of

Princeton, Stevens Institute, the Massachusetts Institute of Technology, Rensselaer, Cornell and the University of Pennsylvania are among those to be represented at the exhibit. There will be a special exhibition of the works of the late Dr. Elmer A. Sperry, past president of the society, at the museum, as well as motion pictures and a sound cartoon explaining the production and exhibition of talking pictures.

THE *British Medical Journal* states that on the occasion of its tenth annual meeting the German Society for Diseases of the Digestive System and Metabolism has founded a Boas prize of the value of 1,000 marks. The subject is the bacterial and non-bacterial origin of diseases of the pancreas. Candidates should send in their essays by April 1, 1931, to the general secretary, Professor R. von den Velden, 30, Bambuga Strasse, Berlin, from whom further information can be obtained.

COLUMBIA UNIVERSITY will receive $173,232 under the will of Miss Euretta J. Schlegel, who died in Brooklyn on December 4, 1929. The legacy is provided for the purpose of establishing fellowships "for the study of letters at Oxford or Cambridge."

THROUGH error in transcription the Central Chemical Company of Chicago instead of the Central Scientific Company was credited in a recent issue of SCIENCE with endowing a national chemical fellowship at the Johns Hopkins University.

UNDER the will of the late Lord Brotherton, who died on October 21, the University of Leeds will receive £100,000 for general purposes, and in addition a gift to the university library of his collection of books, with an endowment for upkeep.

A REVISION of the graphical symbols used in radio communication has been prepared by a technical committee under the auspices of the American Standards Association and is now being considered by the Institute of Radio Engineers for submittal to the association for approval. The purpose of the revision is to eliminate any possible confusion between radio symbols and the symbols used in other branches of engineering. A general committee on scientific and engineering symbols and abbreviations, working under the American Standards Association procedure, has already completed national standard symbols for hydraulics, for heat and thermodynamics, for photometry and illumination, for aeronautics, for mathematics, for electrical quantities, for telephone and telegraph use, and for navigation and topography. The American Association for the Advancement of Science, the American Institute of Electrical Engineers, the American Society of Civil Engineers, and the American Society of Mechanical Engineers are joint sponsors for the work of the technical committee which prepared the symbols.

THE *Journal* of the American Medical Association reports that the board of health for the University of Iowa, authorized by President Walter Jessup, was recently organized and its divisional work inaugurated with headquarters at the student out-patient service offices. The personnel includes Dr. Henry S. Houghton, professor and dean of the college of medicine, chairman; Dr. Fred M. Smith, professor and head of the department of theory and practice of medicine; Dr. Milford E. Barnes, professor and head of the department of hygiene and preventive medicine, secretary, and Dr. Carl E. Seashore, head of the department of psychology and the graduate college; Mr. Robert E. Rienow, dean of men; Miss Elizabeth Halsey, professor and head of the department of physical education for women, and Dr. Edward H. Lauer, professor and director of the division of physical education. With the approval of Dr. Daniel C. Steelsmith, state commissioner of health, the university board will enforce regulations of local health officers and remove possibilities of menace to health arising from the existence of the hitherto "no man's land" in the form of state owned properties. The activities of the new board will include the inspection division, under the direction of Mr. Jack J. Hinman, Jr., assistant professor of sanitation and chief of the water laboratory which will carry out the sanitary inspection of all buildings under the direction of the quasi control of the university and all water, milk and food supplies and swimming pools. The communicable disease section, under Dr. Carl F. Jordan, assistant professor of hygiene and preventive medicine, will investigate and act on all reportable and communicable diseases within the university health district; those cases involving extramural action will have close cooperation with the local health authorities. The life extension division, under Dr. Chester I. Miller, chief of the student out-patient department, and Drs. L. B. Hanson and Grace E. Williams, examiners for men and women, respectively, will handle students, nurses and employees. The health examinations now required of all freshmen will be extended to include all incoming registrants and all prospective graduates during their final year. The student out-patient department will be supervised by Dr. Miller and will care for student illnesses, and those in need of additional service are referred to the hospital, for which a nominal charge is made.

ARRANGEMENTS have been made by the Department of Conservation and Development for the first large-scale planting of Asiatic chestnut trees in North Carolina by federal and state officials in an effort to replace the native tree destroyed by blight. Five thou-

sand seedlings, which range from two to three years in age, have been acclimatized at the State Forest Nursery near Clayton. They will be planted almost exclusively on publicly owned lands that their growth and condition may be checked closely. Settings will be made in orchard formation to assure a future supply of nuts if the trees thrive in their new environment.

DISCUSSION

CONSIDERATIONS LEADING TO THE VIEW THAT PELLAGRA IS AN IRON-DEFICIENCY DISEASE

THERE are so many facts recorded in the literature which tend to support the idea that iron deficiency occurs in pellagra that it seems curious that no one has suggested that the etiology of pellagra is in some way related to iron deficiency. At least the writer has not found such a reference.

Pellagra is practically unknown in very young infants (first year or two). In this connection it is interesting to note that children, puppies, kittens and rabbits are born with an iron concentration of about three times that found in adults. It is worthy of note that the young just mentioned get their first nourishment from milk which has a low iron content, while guinea-pigs, which feed like adults as soon as born, have no higher iron concentration than full-grown animals.

It is recorded that in the investigations of the Thompson-McFadden Pellagra Commission the disease was found to be more prevalent in women than in men—and particularly within the age limits of 19 to 44 years. Between these ages the menstrual cycle in woman causes her to lose 250 cc or more of blood each 28 days. Calculating the hemoglobin content of blood as 10 per cent. and iron as 0.335 per cent. of hemoglobin, the daily loss of iron by this route alone is 3.00 mg. Sherman estimates that such daily loss may average 3.0 mg. Unless the food eaten contains abundant iron this loss, in women certainly, operates to cause a depletion of the amount of iron in the body. Pellagra, in the United States, occurs almost wholly among the rural population of the Southern states, and is found chiefly among those whose economic status forces them to subsist upon a diet made up largely of corn bread and syrup—a diet low in iron. The low iron content of the diet of the women in the rural districts in the South, coupled with the regular losses of iron during menstruation, therefore, are in harmony with the view that the higher incidence of pellagra in women between the ages of 19 and 44 years is related to an iron deficiency. In connection with the foregoing it is also interesting to note that the symptoms of pellagra are usually ameliorated during pregnancy.

Largely as the result of the work of Goldberger and his associates it is generally believed that the heat-stable portion of vitamin B (called the P-P factor or vitamin G—after Goldberger) protects against pellagra. This work of Goldberger has made less of an impression upon clinicians and laboratory workers in the South who are in actual contact with the disease than might be inferred from its ready acceptance in standard texts to-day. Assuming, however, that there is such a "vitamin," its exceptional stability towards heat and its concentration by absorption on kaolin lend themselves suggestively to the idea that the active agent may, indeed, be iron.

Goldberger and his associates adopted the working hypothesis that black-tongue of dogs is the analogue of pellagra in man, and they found that diets which are effective in preventing pellagra in man are also effective in preventing black-tongue of dogs—and the same is said of the curative effects of those diets. Examination of the protocols published by Goldberger reveals the fact that those diets which prevented or cured black-tongue in dogs are just those to which had been added "syrup iodid of iron U.S.P.," and those diets which when fed to dogs produced black-tongue or failed to cure the disease are those to which no iron had been added. Apparently the iron was not added to or withheld from those diets with any intent to affect the balance of the element, because the footnote explains that it was added to "improve the mineral composition of the diet." They make no further mention of iron.

Further, it may be said that the foods which are supposed to contain liberal quantities of vitamin G (beef, liver, egg yolk, yeast) are all iron-containing foods (some of them being among those containing more iron than any other known biological product), while the pellagra-producing diet of poor farmers of the South (molasses and corn bread) is extremely poor in iron.

The anemia which is a very frequent concomitant of pellagra may be yet another finger pointing to an iron deficiency in pellagra.

The achlorhydria of pellagra would certainly promote a greater than normal alkalinity in the region of the duodenum, and the lessened solubility of iron salts in an alkaline medium would hinder their absorption—for it is known that it is there that iron is almost wholly absorbed.[1]

[1] A. B. Macallum, "On the Absorption of Iron in the Animal Body," *Journal of Physiology*, 16: 268, 1894.

Kollath,[2] working with rats, found that the administration of alkaline hematin served to prevent the symptoms which ordinarily supervene when the P–P factor or "vitamin G" is withheld from the diet. The above reasoning leads one to question whether or not it was the iron, so given, that conferred the benefit.

While none of the considerations here outlined prove that pellagra is an iron-deficiency disease, there is much plausibility to the view, and the writer has adopted the working hypothesis that pellagra is an iron-deficiency disease, and has set out to prove or disprove the thesis.

During the past summer the results of iron therapy have been studied in 51 cases of human pellagra. In severe cases, the iron was administered intravenously, and in milder cases it was given orally.

Although the clinical course of this disease is so variable that it is difficult to make a reliable prognosis in any single case, the results obtained are of a very encouraging nature. A more detailed report of these clinical studies will be published elsewhere.

Our studies included one series of dogs with black-tongue—believed by some to be the canine analogue of human pellagra. The animals were maintained on the Chittenden-Underhill diet of peas, cracker meal and cotton-seed oil. The dietary deficiency disease first described by the above-mentioned authors was produced in all its severity, and when the dogs in this condition received iron by the intravenous route, without any other alteration in the régime, they were restored to a normal appearance as judged by the disappearance of characteristic symptoms, return of appetite and an increase in body weight. These experiments are being repeated, extended and amplified, and will be reported in due course.

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SUPPLEMENTAL NOTE REGARDING MOSQUITO VECTORS OF EXPERIMENTAL YELLOW FEVER

IN a recent issue of this journal, the writer[1] summarized, in brief, attempts of several investigators to transmit experimental yellow fever through mosquitoes of various species. Shortly afterward abstracts of the work of Dr. Shüffner and his coworkers with *Aedes* (*Stegomyia*) *albopictus*[2] and of de Vogel with *"Stegomyia scutellaris"*[3] came to hand. As these mosquitoes are important semidomestic insects in the Far East, it seems of importance to call attention to these additional data. In biting experiments, the former authors report one fatal infection in ten rhesus monkeys tested, and de Vogel obtained only non-fatal infections in six monkeys, although a blood subinoculation from one of the latter produced death in another animal.

A point in taxonomy is raised in connection with the above two mosquitoes. On the basis of misidentified specimens, Theobald sank *A. scutellaris* into synonymy with *A. albopictus*. Both Edwards and Barraud have since corrected this mistake, placing *A. scutellaris* Walk. nec Theo. as a synonym of *A. variegatus* Bigot. Walker's type came from the Dutch East Indies, and the present distribution of *A. variegatus* is given as "Christmas Island, South of Java and many Pacific islands." *A. albopictus* occurs throughout the oriental region.

One would be inclined to conclude on the basis of the abstracts that two distinct species of mosquitoes were used by the above investigators, but I am informed that in his original article de Vogel treats the *"Stegomyia scutellaris"* with which he was working as synonymous with *A. albopictus*.

While the results of transmission experiments with *A. albopictus* do not indicate this species to be as favorable to the virus as the Javanese *A. aegypti*, which were also tested, or the West African *stegomyiae*, in our experience, yet incrimination of this ubiquitous oriental mosquito constitutes information of high potential value in prophylactic measures.

Taeniorhynchus (*Mansonioides*) *africanus* and *Aedes vittatus* are two important species incriminated by the writer in experimental yellow fever transmission which also occur in the Far East. With *A. aegypti*, the common host of that disease, and *T. uniformis*, an untested but very close relative to *T. africanus* which should be equally capable of acting as a host, also widely distributed in that region, one dreads to contemplate the appalling situation that would develop should the virus of yellow fever ever become established in East Africa and thence be spread into the vast, densely populated Orient.[4]

CORNELIUS B. PHILIP

HAMILTON, MONTANA

[2] W. Kollath, "Water-soluble Vitamins and Their Relation to Each Other" (abstract), *Chemical Abstracts*, 24: 1887, 1930.

[1] C. B. Philip, SCIENCE, 71: 614–615, June 13, 1930.

[2] J. E. Dinger, W. A. P. Schüffner, E. P. Snidjers and N. H. Swellengrebel, *Nederl. Tijdschr. v. Geneesk.*, December, 1929, No. 51, pp. 5982–91.

[3] W. de Vogel, *Bull. Office Internat. d'Hyg. Publique*, February, 1930, 22: 282–286. Abstracts in *Trop. Dis. Bull.*, 27: 486–487, June, 1930.

[4] The writer is indebted to Dr. C. E. Mickel and Mr. W. B. Owen, of the University of Minnesota, and to Dr. H. W. Kumm, of the Rockefeller Foundation, for references in connection with the systematic points referred to above.

ANOSMA OR "SQUEEZE-UPS"

THE Sunset Crater Lava flow lies fifteen miles northeast of Flagstaff, Arizona, and presents the most recent evidences of volcanic action in the San Francisco Mountain area. The surface of the flow bears curious fissures. These fissures are filled with basaltic masses which have been given the name of anosma[1] or "squeeze-ups."[2]

The Sunset Lava flow, called by Robinson, 1913, the Bonito flow,[3] seems to arise from a fissure at the northwest base of Sunset Crater. From the point of origin now marked by a line of fumeroles, the basalt flowed west and north spreading fanlike over an intercone basin, a basin in which the natural drainage has been blocked by cinder cones. That the flow had two phases is very evident. During the primary phase the flow extended about a mile from the vent. Following this flow an ash fall covered the surface. From the fringes of the primary flow a series of secondary flows poured out into the basin. These flows were probably contemporaneous, as they have coalesced to form an apron in some places a few hundred feet wide and in others almost a mile. The scoriaceous surfaces of the secondary flows are free from volcanic ash. We can, therefore, conclude that an ash fall occurred in the interval of time between the primary and the secondary flows.

The primary lava flow is cut by a fissure. This fissure extends from near the base of Sunset Crater a mile and a quarter northwest to the edge of the primary flow and varies in width from a few feet to seventy-five feet. Through this fissure basalt in a plastic condition has been squeezed. The sides of this basalt tongue are grooved, conforming to the walls of the fissure, and slickenside[4] surfaces are usually present. In the wider parts of this fissure, the more plastic inner layers of the mass seem to have slid over the outer less plastic plates so that we find a series of vertical layers pushed into the air.

That the mass was plastic, like stiff clay, is evident from the rough surface of the sides of the plates that have been in contact with the walls. Small lunar-shaped sharp ridges something less than a quarter of an inch high in parallel series, with an axis perpendicular to the direction of the up-thrust, are observed on the surface of the plates, a condition often seen in the molding of bricks. Again, the thin plates of basalt by the effect of gravity have arched over as they were pressed up into the air. All these facts testify to the plastic nature of the basalt.

Besides the long squeeze-up, mentioned above, others are known, many of them less than two hundred feet long, and one is over one hundred and twenty feet wide. All these squeeze-ups are located on or near the edge of the primary lava flow and form points of origin of secondary flows. One fissure but two feet wide contains a squeeze-up the top of which does not reach the surface.

If we trace the big squeeze-up to its northwest end we are led to a tumbled mass of lava where squeeze-ups radiate in all directions. This wild weird place, which we have called the "Mother of Squeeze-Ups," forms the source of one of the larger peripheral secondary lava flows. Here, the scoriaceous lava can be seen to have oozed out of the crack between the squeeze-up and the primary flow.

The remains of numerous fumeroles dot the surface of the primary flow but are absent on the surface of the secondary flows. Silicious deposits and the oxidation of the iron in the basalt on the surface of the primary flow tell of the action of hot gases. These observations indicate that the lava beneath the primary flow was long in cooling. The squeeze-ups, therefore, seem to have some relation to a deep mass of basalt slowly cooling but still connected with the active vent.

Dr. T. A. Jaggar, of the Hawaiian Volcano Observatory, in a letter, suggests that this condition may be similar to "Schollendomes" in Hawaii. He states that often a lava flat is swollen up at the front of a flow. Lifting the shell is easier than pushing it out. The paste inside breaks through the roof of the dome so formed. The inside is much like a laccolith. In Hawaii, however, the lava is never stiff enough to stand up in arches.

Except at the edge of the primary Sunset lava flow the lava seems to be in hydrostatic equilibrium. In other words the average height of the squeeze-up plates are lower than the surface of the primary flow, although individual thin plates may extend ten feet or more into the air over the level of the flow.

Anosma or squeeze-ups seem to be unique. Good examples are abundant on the primary lava flow from the northwest base of Sunset Crater.

HAROLD S. COLTON
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[1] Name suggested by Dr. H. Lamar Crosby, of the University of Pennsylvania. A brand new name derived from the Greek, meaning something pushed up.

[2] Suggested by W. M. Davis, Harvard University.

[3] H. H. Robinson, "San Francisco Mountain Volcanic Field," U. S. G. S. Prof. Paper No. 79, 1913.

[4] It may not be literally correct to refer to "slickensides" in a plastic medium but the writers know no other word.

MOSQUITOES VERSUS CULICIDAE

How many readers of SCIENCE are accustomed to swatting culicids? A very small number of us may delve academically into the habits of the Culicidae;

all of us at one time or another have been acutely concerned in the "control" of mosquitoes. As a member of the latter class, most of whose members must confess to academic delving in some other field, the writer wonders if the value of G. A. Mail's recent note in SCIENCE[1] would not have been increased many fold if *Aedes campestris* had been presented as a mosquito rather than as a culicid.

The writer, who knows and probably overuses a lot of long names in his own branch of study, was able to deduce from the origin of the above-mentioned note in an entomology department the fact that *Aedes campestris* is some species of insect, but a dictionary was essential to further appreciation of an otherwise interesting contribution. The very brevity of the statement suggests that it was addressed to a larger group of readers than those who readily recognize Culicidae as the family name of the mosquitoes. Should not the author, or the editor, have given those of us who scan SCIENCE in search of adult education more initial encouragement by featuring "Mosquito" rather than "Culicidae" in the parenthetic title?

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SPECIAL CORRESPONDENCE

AEROLOGICAL STATIONS IN GREENLAND 1930–1931

FOR the first time a number of aerological stations each set up for the period of a year are now operating in Greenland. The outline map of Fig. 1 shows the approximate positions of the eight stations (1–8). Six of them are now, it is believed, sending up pilot balloons on all fair days.

First in importance are the stations of the German Expedition under Dr. Alfred Wegener (1–3), the veteran Greenland explorer and meteorologist, following upon his important preliminary studies carried out on the west coast in 1929.[1]

Recent radio reports published in the New York *Times* show that his station near the central axis of the inland-ice about 250 miles distant from either coast and about 10,000 feet above the sea (1) has already for a good many weeks been functioning under Dr. J. Georgi. The station on but near the western margin of the ice (2) is also reported to be in operation. Wegener's eastern station under Dr. Kopp was to have left Copenhagen in July and to be located on Scoresby Sound near sea-level and as near as possible to the inland-ice. All these German stations are near latitude 71°.

The University of Michigan stations (4 and 5) are on the west coast about equally distant north and south from the Mount Evans aerological station (9) which was operated from July, 1927, to July, 1929, but is now closed. Letters received from William Carlson in charge of the northern station indicate that he was erecting his observing station on the summit of a small island 400 feet above sea-level in latitude 72° 50′ and only two miles distant from the inland-ice. Balloon ascents were to begin on September 1. Evans S. Schmeling, of the southern station, is at the settlement of Ivigtut in extreme south Greenland (latitude 61°). Letters from him dated in late August indicate that he was to begin regular balloon ascensions on September 1.

The British Arctic Air Route Expedition, according to radio reports from the New York *Times*, has now for a number of weeks been operating its station on the inland-ice near the central axis (8) and thus in a position similar to Wegener's station 1; as well as a station at the expedition's base on the Sermilikfjord near the Danish settlement of Angmagssalik (7) in latitude 66°.

[1] G. A. Mail, "Viability in Eggs of *Aedes campestris* Dyar and Knab (Culicidae)," SCIENCE, 72 (No. 1859): 170, 1930.

[1] A. Wegener, *Zeitsch. d. Gesell. f. Erdkunde z. Berlin*, 1930, nos. 3–4, pp. 81–124.

The remaining Greenland station (6) is that of a party of Norwegian hunters supplied with pilot balloons at their station of Mygbukten (Mackenzie Bay) in latitude 73°, where they are operating under the auspices of the Meteorological Institute of Oslo.

UNIVERSITY OF MICHIGAN WILLIAM H. HOBBS

SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPROXIMATE METHOD FOR DETERMINING THE SAME DEGREE OF ANESTHESIA FOR FISH

THIS method is primarily one of electrical stimulation. While it is not hair-splitting in accuracy, still it is very reliable, the criterion for this statement being the number of times the anesthetizing time for any particular fish in the same strength solution checks. The accuracy of this method, of course, depends a great deal upon the acuteness of the power of observation of the operator.

APPARATUS

Fig. 1 illustrates the apparatus used. This consists of a glass cylinder A fastened to a ring-stand by

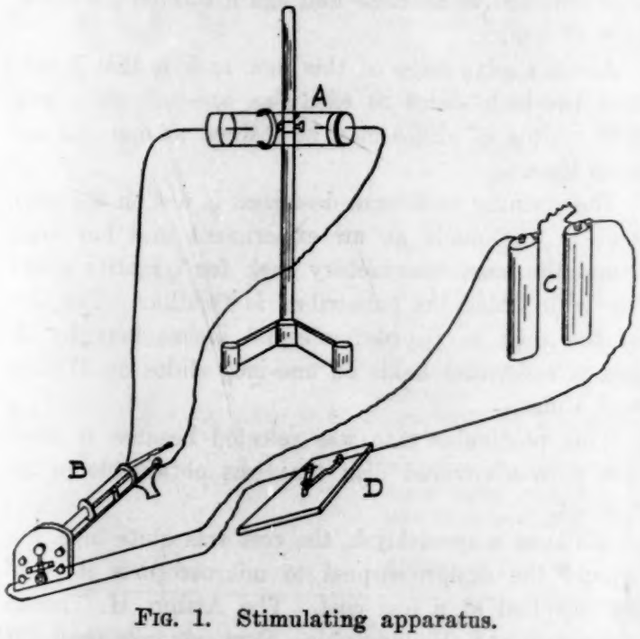

FIG. 1. Stimulating apparatus.

means of a clamp, induction coil B, two dry cells C, a simple key D and two copper stimulating electrodes leading from the secondary coil into the glass cylinder A. Cylinder A is sealed by two rubber stoppers through which the electrodes protrude. The stimulus consists of tetanic induced current from an inductorium receiving its current from the two dry cells. In order to insure the same strength of current (which has been previously determined to be the optimum stimulus), the secondary coil must always remain at the same position in the inductorium. The dry cells should also be tested at regular intervals with the voltmeter. The electrodes leading into the glass cylinder A should be cleaned thoroughly every time the apparatus is put into use. The interrupter points of the inductorium should be readjusted in order to maintain the pitch of the vibrator. The circuit is established by closing the simple key D.

TECHNIQUE

Cylinder A is placed in a vertical position and filled about four fifths full with the solution to be tested. The same number of cubic centimeters should be used each time. The fish is introduced immediately into the cylinder, at which time a stop-clock is started. The removable stopper is replaced and the glass cylinder returned to the horizontal position. After a second or so, depending upon the strength of solution, the fish is stimulated at intervals by pecking on the simple key D until it gradually becomes less and less irritable. Finally the response obtained will change from an active response of the whole fish to local muscular contractions of the tail at which point appear also, to a close observer, tremors comparable to "ether tremors" as reported by Hewitt.[1] It is a mistake to continue stimulating until no response is received, because in the majority of cases where this is done the fish will not recover.

It can then be seen by the above brief description that the success of this method depends upon (1) keeping the strength of current as nearly constant as possible; (2) the ability of the operator to recognize the transition from response of the fish as a unit to local contraction of the tail muscles, and (3) the recognition of the accompanying tremors.

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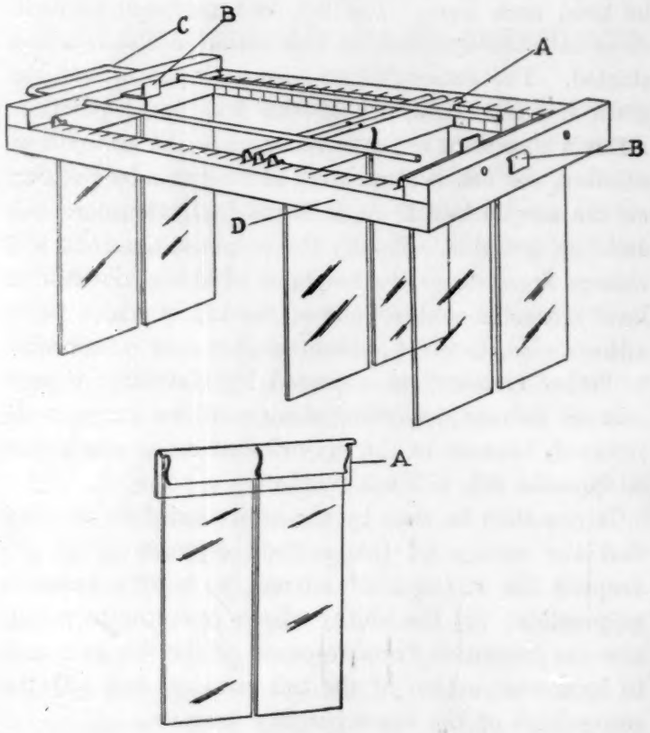
A NEW STAINING RACK FOR MICRO-SLIDES

THE rack here described and illustrated consists of a metal frame (D) appropriately slotted to receive a number of metal clips (A) of a particular design, which hold the micro-slides. The frame and clips are made of non-corrosive metal. However, no part of the rack, neither frame nor clips, is immersed in the staining bath. The clips are made of thin strips of an elastic metal folded lengthwise, the fold viewed on end having somewhat the bend of the traditional shepherd's crook. One side of the fold is wider and longer than the other; the projecting ends of this side, the upper borders of which are bent over in the

[1] Hewitt, "Anesthetics," p. 363, 1912.

direction of the fold, fit into the slots in the frame and hold the clips in place. The shorter fold of the clip is cut in half by a vertical slit. The clips are designed to hold the slides by one end only. Each clip will hold two slides each one inch wide, or one wider slide up to two inches in width. When two one-inch slides are in a clip, either can be removed without disturbing the other. In use, the two end clips and their slides are made to serve as legs, or supports, for the rack by pushing in the catch (B) at each end of the frame; the other clips with their slides are then dropped in place. The rack and clips are supported by these legs above the level of the staining bath. Every clip in the frame is held independently of the others and apart from the two end clips serving as legs, as few or as many as may be desired can be put in up to the capacity of the rack. Any clip with its slides, except the end ones, can be readily removed for examination at any stage of the staining process without disturbing the others. If desired, all the clips in the frame can be secured against falling out when the rack is in any position by sliding the U-shaped rod (C) into the holes in the ends of the frame.



Compared with the ordinary basket-like type of rack in which the rack and slides are more or less completely submerged in the staining bath, this new rack, in contrast, is not immersed at all; only the free portions of the slides are immersed and then not more than deep enough to submerge the specimens on them. On taking the slides out of the bath, the quantity of fluid adhering and withdrawn with them is small in comparison with that taken out by the ordinary style rack. A noticeable economy is achieved in the quantity of stain used, and at the same time the quantity carried over into any succeeding bath, contaminating it more or less, is reduced to the minimum practicable in quantity staining.

When compared with other staining racks in which the slides are held at one end but secured by a screw this new rack is decidedly the more convenient to work with; the slides can be taken out and put back without disturbing the others and in a fraction of the time required to unscrew and again tighten the screw type of holder.

Another advantage of this new rack is that it will hold two-inch slides as easily as one-inch ones, and both widths of slides may be stained at one and the same time.

The staining rack here described is not on the market; it was made as an experiment and has been found the most satisfactory rack for quantity staining with which the subscribed is familiar. The size of the rack is approximately 6 inches long by 2¾ inches wide, and holds 62 one-inch slides or 31 two-inch slides.

This particular size was selected because it fitted nicely in a covered dish that was obtainable in the market.

Made as a special job, the cost was quite high, but should the design appeal to microscopists it could be supplied at a less cost. The Arthur H. Thomas Company, of Philadelphia, Pennsylvania, had the rack made for me.

W. F. R. PHILLIPS

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SPECIAL ARTICLES

THE LETHAL DOSE OF ULTRA-VIOLET LIGHT FOR BROOK TROUT (SALVELINUS FONTINALIS)

MANY chemical agents have been studied by fish culturists in attempts to check the epidemics of parasitic diseases that frequently cause severe financial losses in the best trout hatcheries. Although some of these agents are quite effective in checking fungus growths, they are often difficult to apply since the fish must be removed from the troughs and the troughs must be sterilized separately.

Ultra-violet light affords new opportunities for the control of fish diseases. It is unique in providing a means for the simultaneous treatment of both the fish and the water in which it swims. Since no experiments have been reported which deal with the ultra-violet radiation of normal fish we have summarized in the accompanying table some of our data. Before being radiated the trout were placed in a wire cage twelve inches square. This cage contained a screen bottom and top so that the fish could be confined in a water stratum at a definite distance from the surface. Ten trout about 2 to 3 inches in length were used in each experiment. During the radiation the trout were kept in their usual habitat of flowing spring water at a temperature of 10° C.

TABLE I

THE LETHAL DOSE OF ULTRA-VIOLET RADIATION FOR BROOK TROUT

Depth of water in inches	Distance of lamp from water in inches	Time of exposure in minutes	Time between exposures in hours	No. of exposures	No. trout killed	Results
1	6	5	24	3	4	Two died after third exposure. Two more died next day.
1	12	5	24	4	1	One died fifth day—others appeared grayish as if burned.
1	6	3	24	5	10	Three dead after fourth exposure. Four more dead after fifth exposure. Rest died next day.
1	12	3	24	16	1	No deaths until tenth day. Had not appeared normal or eaten well for a few days before.
1	12	3	18	5	0	No deaths. Held for 6 days after last exposure.
3–4	12	1	24	10	0	Apparently no detrimental effect.
3–4	6	90		1	3	Very grayish in appearance when removed—two died next day, one some time later. All appeared burned.

Our table shows that trout are killed by one long period of radiation or by a series of short periods at daily intervals. It also shows that trout can withstand a certain amount of radiation without injury. This affords a zone for further experiments in attempts to destroy the parasites without injuring the fish. No reliable comparison can be made between the sensitiveness of fish and the higher animals to ultra-violet radiation since the penetration of water by ultra-violet light seems unsettled. If water is readily penetrable, trout are less sensitive to radiation than man; if the reverse is true they are probably more sensitive.

The lamp used in these experiments was the Uviare poultry lamp which was furnished us through the courtesy of the General Electric Company.

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C. M. MCCAY

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ON THE OXIDATIVE NATURE OF THE NERVE IMPULSE[1]

A YEAR or so ago I succeeded in demonstrating[2] that although nerve conduction may go on in nitrogen for some time, for which chemically bound oxidative reserves were presumably used, no excess carbon dioxide was given off as is the case in aerobic conduction. The tentative view was adopted that the initial phase of conduction, manifested by the action potential as usually recorded, was conditioned by if not caused by a union of some substance in nerve with oxygen, rather than a complete oxidation with the accompanying production of carbon dioxide. I attempted at that time to determine manometrically whether this oxygen, required for stimulation, had first to be activated or whether molecular oxygen sufficed. Owing to inadequacies in the technique, the results were only suggestive and were not published. This work was made the starting-point of a program of research aimed at a clearer elucidation of the physical chemical processes responsible for the propagation of the impulse in nerve; the purpose of the present notice is to report a few of the results thus far obtained.

For this work I have turned to the theory of Warburg as being the most promising experimentally. Warburg believes to have shown that the respiratory enzyme is an iron-containing, hemin-like substance which can be poisoned by cyanides, hydrogen sulphide and carbon monoxide. Neither Warburg nor his collaborators have ever worked on nerve, however. Hence it became our first task to see whether nerve behaves towards these poisons as does Warburg's yeast.

To be very brief, it appears that sodium cyanide may inhibit nerve respiration very completely. In dilute solutions, *e.g.*, N/1000 NaCN, the inhibition is

[1] From a paper presented at the Marine Biological Laboratory, Woods Hole, Massachusetts, on July 25, 1930, and summarized in *The Collecting Net*, 5: 145, 1930.

[2] F. O. Schmitt, *Biochem. Zeitschr.*, 213: 443, 1929.

complete only for an hour or so, thereafter wearing away to a certain residual amount. In strong solutions, *e.g.*, N/10 NaCN, the inhibition is practically constant from the first and amounts to 80 to 95 per cent. The explanation of the escape from inhibition is to be found, perhaps, in the expulsion of HCN from the inner fibers by the lactic acid as a result of the anoxemia produced since lactic acid is stronger than HCN by some six orders; the effect may also be due somewhat to a relatively slow outward diffusion of the lactic acid.

Similarly it was found that nerve respiration may be inhibited fairly completely by carbon monoxide in the dark. The constant expressing the relative affinities of the carbon monoxide and oxygen for the iron catalyst represented by the equation $n/1-n\cdot CO/O_2=k$ was found to approximate closely to the value of 10 as was found for other cells by Warburg. Furthermore, illuminating the nerve causes a marked decrease of the carbon monoxide inhibition of resting metabolism.

By far the most striking results were obtained when the effect of carbon monoxide on the action potential was studied by means of the cathode ray oscillograph. In mixtures containing from 1 to 3 per cent. of oxygen in carbon monoxide it was found that the height of the action potential decreases progressively to extinction, this decrease being considerably faster than in a similar mixture of oxygen with nitrogen. If during this decline in carbon monoxide the nerve be illuminated by means of an arc-light, the height of the action potential rises immediately and may return to, or even exceed somewhat, the original value. It is important to note that the potential rises immediately with illumination but does not drop at once when the illumination is turned off; the return to the original extinction curve usually takes from 20 to 30 minutes. That the effect is not one of temperature rise or of photo-oxidation is shown by the fact that a companion nerve in nitrogen failing along a similar curve is quite unaffected by the illumination. There is some evidence of small rises in potential in illuminated nerves in presumably *pure* carbon monoxide; the explanation of this is at present not yet clear.

The work is not sufficiently far along to warrant any sweeping generalizations, but it seems clear that the action potential is produced by an oxidation or oxygenation of a substance or substances in nerve, and that for this purpose, activation of the oxygen by a respiratory enzyme similar to that of Warburg's is essential. Since nerves usually do not fail in pure carbon monoxide any faster than in pure nitrogen it appears that the function of the iron catalyst is chiefly to make active oxygen available to the irritable mechanism which when stimulated is then capable of producing the action potential. For the further elucidation of the rôle of the iron catalyst and of the oxidations required for the production of the action potential I am attempting to bring together two distinct lines of research: that of manometric measurement of metabolism, and that of the measurement of the electric potential of nerve. Indeed, some progress has already been made in this direction; I refer to the fact that it is now possible in our hands to obtain accurate records of the height, shape, duration, etc., of the action potential of nerves with the cathode ray oscillograph whilst measuring simultaneously their metabolism manometrically. Only by such a union of methods will the questions raised in this report be adequately answered.

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BOOKS RECEIVED

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